State of California
AIR RESOURCES BOARD

MANUFACTURERS ADVISORY CORRESPONDENCE (MAC) 2005-01

SUBJECT: Interim Voluntary Low Emission Standards for New Model Year (MY) 2005 and 2006 Off-Road Large Spark-Ignition (LSI) Engines.

APPLICABILITY: 2005, 2006 MY New Off-Road LSI Engines (greater than 25 horsepower (hp) and greater than 1.0 liter).

REFERENCES:

1. California Health and Safety Code section 43205.

2. Title 13, California Code Of Regulations, Division 3, Chapter 9, Article 4.5 (sections 2430-2439), California Regulations for New 2001 and Later Off-Road LSI Engines (25 and greater hp) and incorporated test procedures.

POLICIES:

1. **Exhaust Emission Standards - Off-Road LSI Engines.** This MAC applies to new equipment that may be certified to voluntary low emission standards. Under this MAC, off-road LSI engine original equipment manufacturers (OEMs) can voluntarily certify LSI engines to not-yet-adopted optional low emission standards of 0.1, 0.2, 0.4, 0.6, 1.0, 1.5, and 2.0 grams per brake horsepower-hour (g/bhp-hr) for hydrocarbons (HC) plus oxides of nitrogen (NOx). The in-use compliance level for engines voluntarily certified to an optional low emission standard is 133 percent of the corresponding HC+NOx standard. In-use emissions must not exceed the in-use compliance level during the 3,500-hour or five-year useful life. Corresponding in-use carbon monoxide emissions may not exceed 15.3 g/bhp-hr. In addition to the in-use and durability requirements, OEM applicants must comply with all certification and warranty requirements contained in Reference 2 above.

2. **Interim Period.** This MAC will no longer be operative when the rulemaking formally adopting new optional low emission standards is completed. However, the terms of the MAC will continue for a manufacturer's engines that were certified under the MAC. Once the optional low emission standards adopted by the Air Resources Board (ARB or Board) become effective, OEMs desiring to certify their LSI engines to the standards will have to meet the provisions of the adopted regulation.

3. **Emission Control Labels.** The ARB recognizes that certain emissions critical or emissions related parts and or engines must be properly identified for fleet users to determine compliance with any applicable regulations. The format must be

consistent with the requirements of Title 13, California Code of Regulations, section 2434, Emission Control Labels – 2001 and later Off-Road LSI Engines. In addition, these labels must identify the exhaust emission certification standard to which the engine is certified.

4. **Averaging, Banking, and Trading.** Title 13, California Code of Regulations, section 2438(e) – In-use emissions credit, averaging, banking, and trading program – provides off-road LSI engine manufacturers an opportunity to voluntarily participate in an in-use credit, averaging, banking and trading (A, B, & T) program. Under the A, B, & T program, manufacturers may generate and bank positive in-use emission credits for their subsequent use. This portion of the MAC summarizes A, B, & T credit terms, the generation of positive and negative credits, and credit calculations. It concludes with some credit generation examples.

A. Definitions

Averaging: the exchange of in-use emission credits among LSI engine families within a given manufacturer's product line. Credits may be exchanged between engine families certified under this MAC and engine families certified under Reference 2.

Banked credits: positive credits based upon production and sales volume as contained in the end of model year in-use testing reports.

Banking: the retention of these credits by the generating manufacturer for use in future MY averaging or trading.

Trading: the exchange of in-use emission credits between participating manufacturers or brokers.

B. Credit Generation and Use

Positive emission credits can be generated by any engine family subject to 2004 and later MY emission standards whose in-use compliance level does not exceed the exhaust emission certification standard.

These credits may be used in the year generated or in subsequent MY for averaging, banking or trading. Credits generated either under the provisions of Reference 2 or this MAC may be used for averaging between engine families certified under this MAC and engine families certified under Reference 2.

A manufacturer may generate negative credits if the manufacturer's in-use compliance level exceeds the prescribed exhaust emission standard for in-use compliance. A manufacturer may use previously banked positive credits or positive credits purchased from another manufacturer to address deficits resulting from negative credits.

Manufacturers must demonstrate a zero or positive credit balance for a particular MY within 90 days of the end of the in-use testing of that MY's engine families.

C. Credit Calculation

Credits to be used in averaging can come from another engine family, a prior MY, or through a trade. Positive credits are discounted 10 percent before use. Thus, approximately ten positive credits are needed to offset nine negative credits. For each participating engine family, emission credits are to be calculated according to the following equations and rounded, in accordance with ASTM E29-93a, to the nearest gram.

Positive Credits (grams) = Sales x (CSTD – CL) x Power x AF x LF x UL

Negative Credits (grams) = Sales x (IUSTD – CL) x Power x AF x LF x UL

Where:

Sales	=	The number of eligible sales tracked to the point of first retail sale in the United States for the given engine family during the MY.
CSTD	=	The exhaust emission certification standard in g/bhp-hr.
IUSTD	=	The exhaust emission standard for in-use compliance in g/bhp-hr.
CL	=	Compliance level of the in-use testing in g/bhp-hr (in-use compliance level).
UL	=	Useful life in hours (5000 hours for engines with displacement greater than 1.0 liter).
Power	=	The average power of an engine family in bhp (sales weighted). The power of each configuration is the rated output in kilowatts as determined by Society of Automotive Engineers J1349 (June 1995) or J1995 (June 1995), as applicable.
LF	=	Load factor; Fraction of rated engine power utilized in-use[1].
AF	=	An adjustment factor for the number of tests conducted, as determined from Table 1 below, except that when a manufacturer concedes failure before completion of testing, the adjustment factor shall be 1.0.

[1] See Title 13, California Code of Regulations, section 2438(e)(7) for default load factors and useful life values.

Table 1: Adjustment Factor

Number of Engines Tested	2*, 4	6	8	10
Adjustment Factor	0.5	0.75	0.9	1.0

*Small volume manufacturer

D. Examples

Table 2 below lists three in-use compliance levels (test scenarios) for Engine Families 1 and 2. Engine Family 1 is certified not to exceed a 3.0 g/bhp-hr emission standard, while Engine Family 2 is certified voluntarily not to exceed a low emission standard of 2.0 g/bhp-hr. If the in-use compliance level exceeds the exhaust emission standard for in-use compliance, the engine will generate negative credits for the manufacturer; if it is less than the exhaust emission certification standard, the engine will generate positive credits. The actual credit equations (Part C above) must factor in the engine's horsepower (power), application load factor (LF) and useful life (UL), and the number of in-use tests conducted (AF).

Table 2: Credit Calculation Examples

Engine Family	Hydrocarbon + Oxides of Nitrogen Emissions (g/bhp-hr)				Credit (g)
	Certification Test	Certification Standard	In-Use Compliance Standard	In-Use Compliance Level	
1	0.2	3.0	4.0	2.5	0.5
				3.0 – 4.0	N/A or 0
				4.5	- 0.5
2	1.0	2.0	2.67*	1.5	0.5
				2.0 – 2.67	N/A or 0
				3.0	- 0.33

*Proposed in-use compliance standard is 133 percent of voluntary low exhaust emission certification standard.